

March 1997

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal and Hydraulics Laboratory
1261 Duck Road
Duck, NC 27949-4472

Contents

Preface	iv
1 Introduction	1
2 Meteorological Data	7
3 Wave Data	12
4 Current Data	17
5 Visual Observations	20
6 Water Levels	22
7 Bathymetry	27

List of Figures

<u>No.</u>	
1	FRF Location Map
2	Month at a Glance
3	Instrument Locations at FRF
4	Meteorological Monthly Summary
5	Wave Heights and Periods
6	Water Levels
7	CRAB Profiles
8	CRAB Profile Envelope
9	FRF Bathymetry (7 March 97)

List of Tables

<u>No.</u>	
1	Instrument Status/Data Availability
2	Gauge Locations
3	Meteorological Data
4	Wave Data
5	Current Meter Data
6	Visually Observed Current Data
7	Visual Observations

8 Water Levels	23
----------------------	----

Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Corps of Engineers, Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

Data from these reports are now available via the World Wide Web at
<http://www.frf.usace.army.mil>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Please note the new web address, <http://www.frf.usace.army.mil>

Your comments and suggestions are welcome.

Introduction

1

The U.S. Army Corps of Engineers, Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919)261-6840 ext.222 (c.baron@cerc.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).

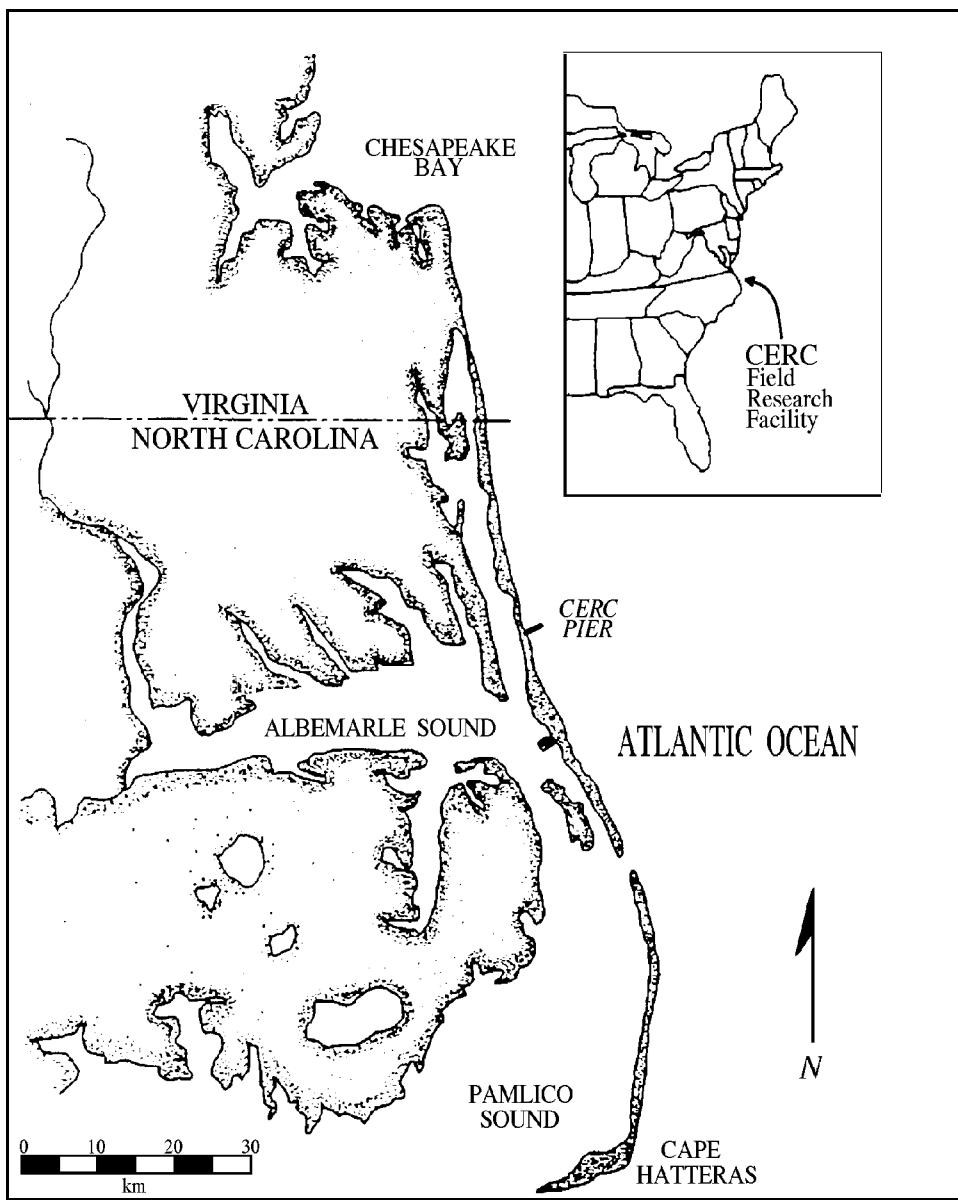


Figure 1. FRF Location Map

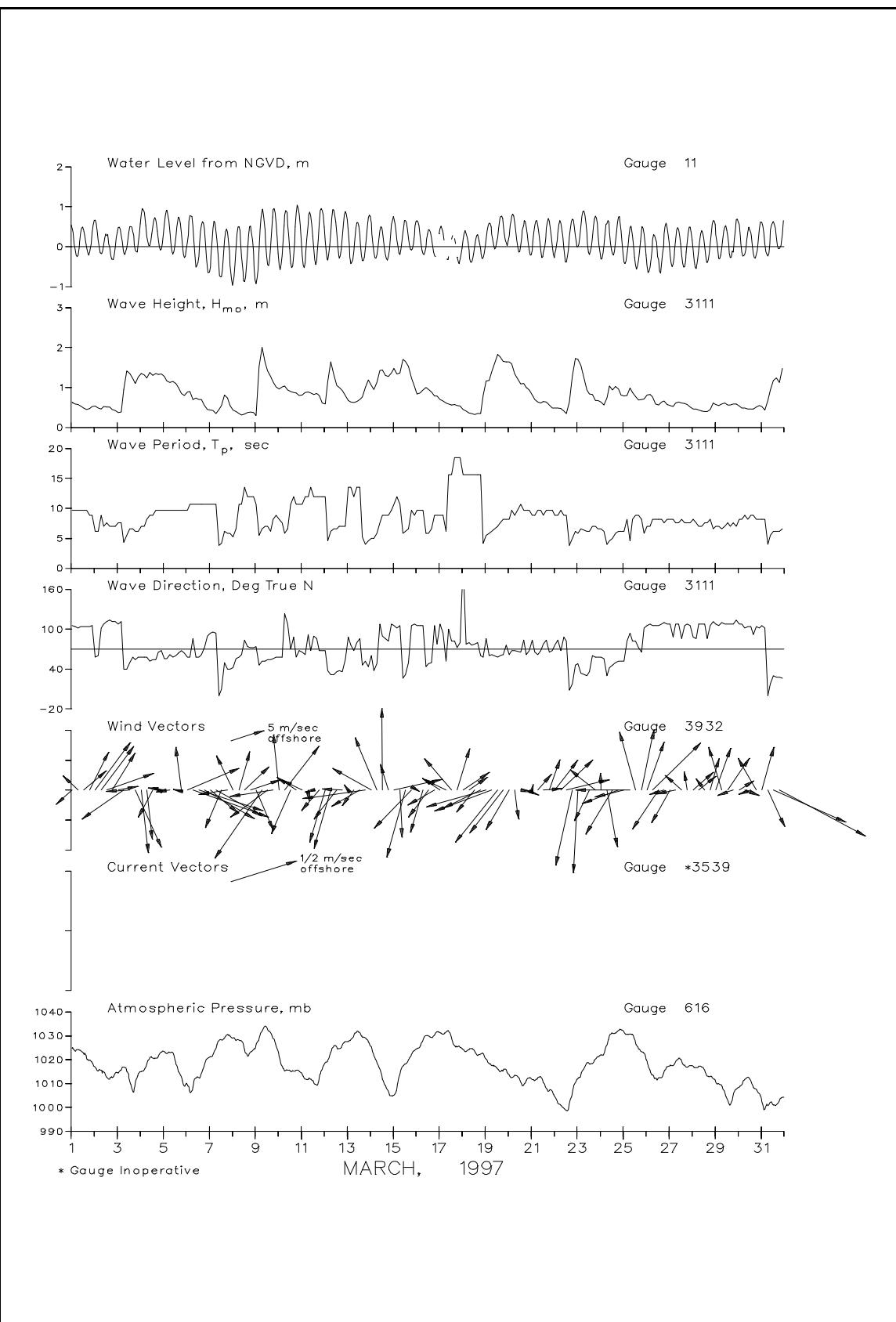


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		March 1997																																		
		Day of the month																																		
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1				
616	Atmospheric Pressure	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
604	Precipitation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
624	Air Temperature	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3932	Anemometer	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
641	Pressure Gauge on FRF pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
625	Baylor staff on FRF pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3111	8 Meter Array 309 m north of FRF	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
111	Pressure Gauge center of 8 Meter Array	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
630	Waiverider buoy 4.0 km offshore	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-				
	Gauge Status	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-				
	Data Collected	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-				
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	Gauge Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
11	NOAA tide gauge at end of pier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
Gauge Status		*	= Operational	/	= Partial	-	= Non-Operational																													
Data Collected		*	= All	/	= Partial	-	= None																													
Visual Observations		*	= Complete	/	= Partial	-	= None																													

Table 2
Gauge Locations

Gauge*	Description	* Latitude	* Longitude	* FRF Coordinates	* Gauge Depth	* Water Depth
ID *		* Degrees N	* Degrees W	* Crossshore ^T Longshore*	NGVD, m	* NGVD, m
*		*	*	*	*	*
*		*	*	*	m	m
616	* Atmospheric Pressure*	36 10' 57.03"	* 75 45' 5.50"	* 11.60	* 569.00	* -----
3932	* Anemometer	* 36 11' 1.23"	* 75 44' 43.07"	* 585.20	* 517.30	* 19.50
641	* Pressure Gauge	* 36 10' 57.71"	* 75 44' 56.23"	* 239.11	* 516.64	* -1.64
625	* Baylor Staff	* 36 11' 1.04"	* 75 44' 43.72"	* 568.00	* 516.64	* Surface
3111	* 8 Meter Array North	* 36 11' 19.14"	* 75 44' 36.41"	* 915.23	* 990.16	* -7.50
		*	*	*	*	*
	* 8 Meter Array South	* 36 11' 11.28"	* 75 44' 33.28"	* 914.20	* 735.37	* -7.42
		*	*	*	*	*
	* 8 Meter Array East	* 36 11' 13.70"	* 75 44' 32.56"	* 954.51	* 800.58	* -7.62
		*	*	*	*	*
	* 8 Meter Array West	* 36 11' 12.48"	* 75 44' 37.11"	* 834.66	* 800.37	* -6.98
		*	*	*	*	*
111	* Pressure Gauge in center of 8 M Array	* 36 11' 14.06"	* 75 44' 34.39"	* 914.43	* 825.52	* -7.76
		*	*	*	*	*
		*	*	*	*	*
630	* Waverider Buoy	* 36 10' 5.10"	* 75 41' 59.30"	* 3934.96	* -2400.81	* Surface
		*	*	*	*	*
		*	*	*	*	*
3539	* Current Meter	* 36 11' 23.57"	* 75 44' 9.12"	* 1605.80	* 907.60	* -11.60
		*	*	*	*	*
11	* NOAA Tide Gauge	* 36 11' 1.25"	* 75 44' 42.60"	* 596.49	* 514.20	* Surface
		*	*	*	*	*
		*	*	*	*	*
R	R	R	R	R	R	R

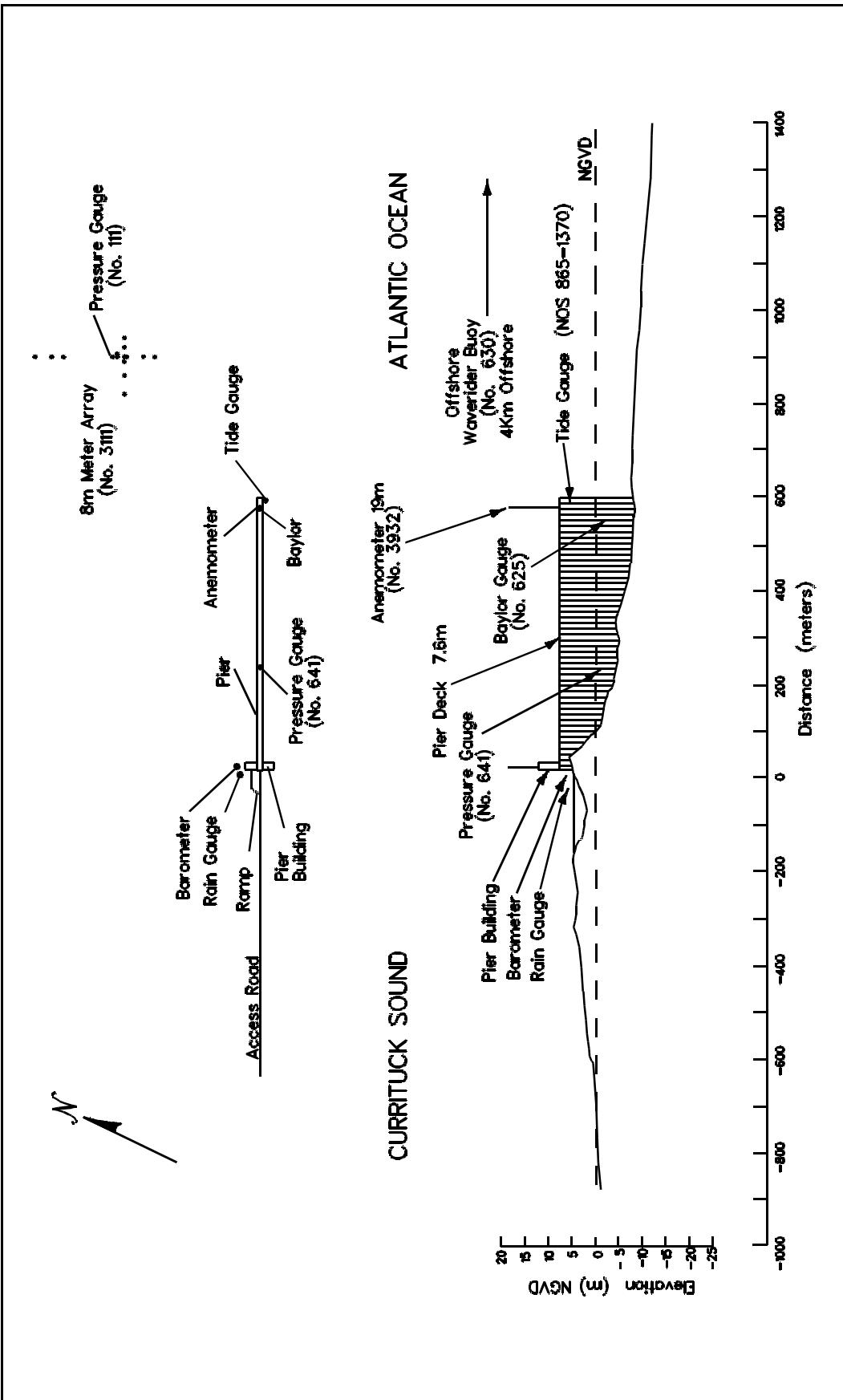


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

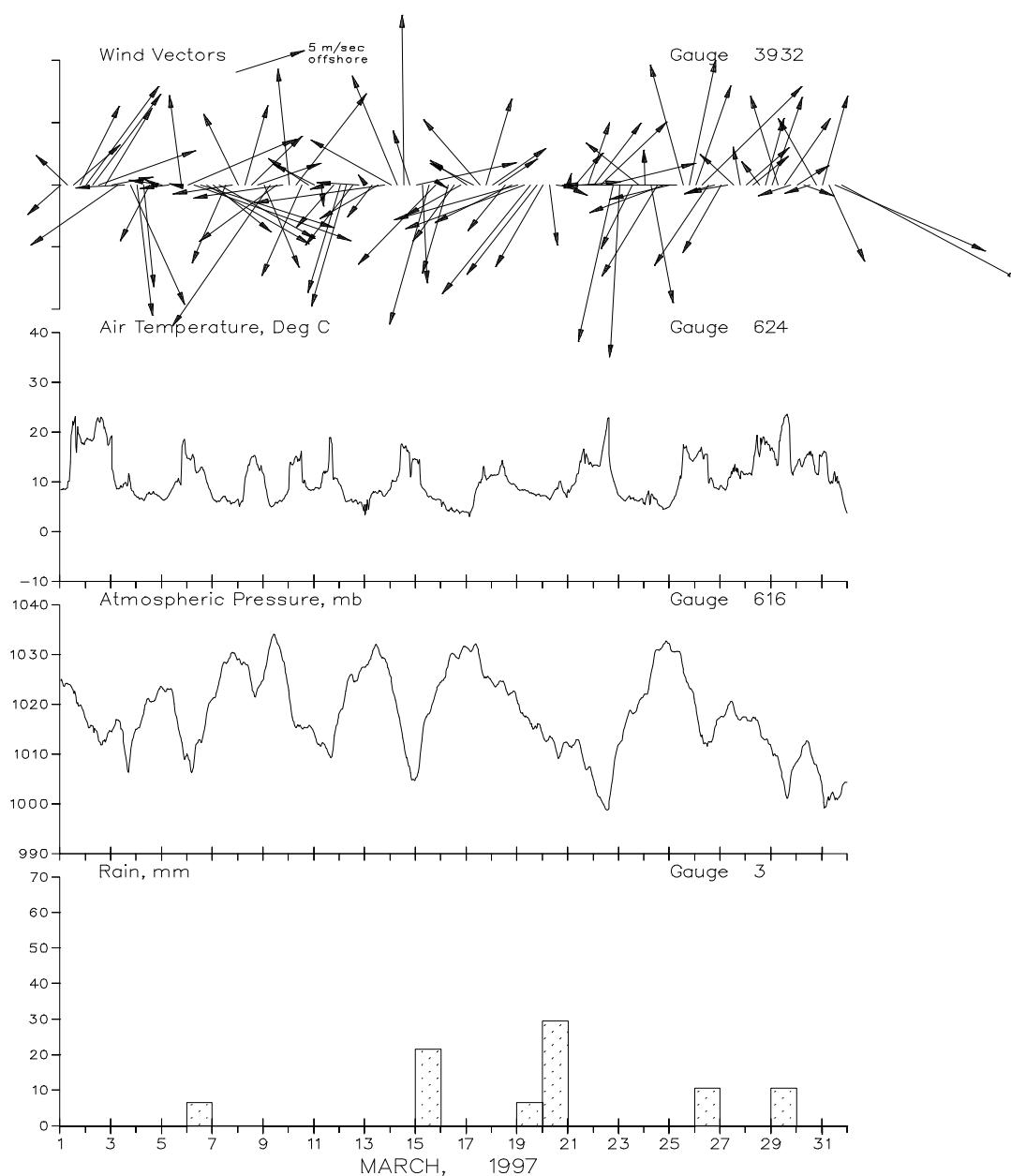


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Mar 1997						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	43	8.4	1024.9	0
	700	3	137	8.8	1024.3	0
	1300	5	225	21.5	1022.6	0
	1900	7	203	18.9	1019.8	0
2	100	9	212	18.3	1016.9	0
	700	9	213	18.3	1015.7	0
	1300	7	247	22.3	1012.7	0
	1900	7	207	20.4	1012.5	0
3	100	3	257	19.2	1014.5	0
	700	8	51	8.6	1017.0	0
	1300	3	1	9.7	1011.1	0
	1900	10	338	9.9	1010.2	0
4	100	11	354	7.0	1015.1	0
	700	8	354	6.3	1018.2	0
	1300	5	24	7.7	1020.7	0
	1900	1	118	7.5	1021.6	0
5	100	2	99	6.5	1023.4	0
	700	2	1	7.3	1023.1	0
	1300	0		9.6	1018.8	0
	1900	7	173	12.7	1012.7	0
6	100	8	243	14.6	1009.6	0
	700	12	1	14.9	1008.6	7
	1300	10	1	12.8	1012.5	0
	1900	9	303	10.1	1018.1	0
7	100	6	313	6.6	1021.3	0
	700	8	303	6.0	1024.8	0
	1300	7	20	6.8	1028.3	0
	1900	4	79	5.7	1030.5	0
8	100	6	156	6.3	1029.0	0
	700	7	193	10.4	1028.2	0
	1300	5	221	15.0	1024.1	0
	1900	5	248	13.5	1023.2	0
9	100	7	1	11.2	1026.3	0
	700	13	30	5.3	1032.0	0
	1300	7	49	5.8	1032.7	0
	1900	6	80	6.4	1028.9	0
10	100	9	174	12.6	1021.3	0
	700	9	213	15.2	1015.3	0
	1300	8	20	12.1	1015.2	0
	1900	3	127	8.5	1015.7	0

Table 3
Meteorological Data (concluded)

Mar 1997							
Precipitation	Wind		Temperature		Atm		
	Day	Hour	Speed m/sec	Direction deg TN	deg C	Pressure mb	
	21	100	1	190	7.9	1011.7	0
		700	3	217	9.9	1012.5	0
		1300	3	265	14.5	1010.5	0
		1900	5	196	14.6	1007.1	0
	22	100	6	213	13.4	1004.5	0
		700	7	222	14.0	1001.1	0
		1300	6	254	20.8	998.8	0
		1900	13	10	10.6	1006.3	0
	23	100	14	2	7.1	1012.2	0
		700	9	12	6.1	1017.2	0
		1300	6	22	6.8	1018.2	0
		1900	5	132	6.1	1020.4	0
	24	100	3	178	5.4	1022.1	0
		700	10	351	7.1	1026.1	0
		1300	8	27	5.6	1031.1	0
		1900	6	66	4.5	1032.2	0
	25	100	4	74	5.3	1031.7	0
		700	8	89	8.1	1030.7	0
		1300	10	166	17.0	1027.1	0
		1900	10	190	14.9	1023.4	0
	26	100	8	196	14.9	1019.5	0
		700	10	221	16.0	1013.9	10
		1300	8	29	9.8	1012.5	0
		1900	2	70	8.8	1015.0	0
	27	100	6	25	9.3	1017.7	0
		700	3	1	9.4	1019.3	0
		1300	3	136	12.0	1019.5	0
		1900	3	1	10.6	1016.9	0
	28	100	4	224	11.7	1017.3	0
		700	3	227	12.9	1017.3	0
		1300	2	146	15.1	1015.6	0
		1900	5	193	17.9	1012.9	0
	29	100	7	196	16.9	1010.7	0
		700	7	164	13.4	1009.1	10
		1300	6	210	22.8	1003.2	0
		1900	2	68	13.4	1005.4	0
	30	100	3	234	13.6	1008.6	0
		700	2	1	13.9	1011.8	0
		1300	2	67	15.4	1011.2	0
		1900	6	153	11.6	1007.8	0
	31	100	7	193	15.7	1002.4	0
		700	7	338	9.9	1000.7	0
		1300	12	1	11.5	1000.9	0
		1900	15	301	8.0	1002.8	0
		Resultant		Mean		Mean	

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Mar 1997								
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array		630 Waverider
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN
1	0100	0.41	9.5	0.66	4.4	0.63	9.8	106
	0700	0.31	9.5	0.62	4.7	0.57	9.8	102
	1300	0.31	9.5	0.53	9.5	0.48	9.8	104
	1900	0.26	9.5	0.50	9.5	0.47	8.9	104
2	0100	0.34	4.5	0.56	6.1	0.54	6.2	58
	0700	0.27	9.2	0.50	5.9	0.47	8.9	102
	1300	0.37	7.2	0.52	7.4	0.51	7.6	112
	1900	0.31	7.2	0.47	7.6	0.45	7.1	112
3	0100	0.28	6.8	0.36	7.6	0.38	7.6	108
	0700	0.53	4.0	0.81	3.9	0.95	4.4	40
	1300	0.93	6.3	1.37	6.3	1.36	6.6	50
	1900	0.66	6.5	1.01	6.1	1.10	6.2	54
4	0100	1.18	7.0	1.44	6.6	1.36	7.1	58
	0700	0.83	7.6	1.20	7.8	1.25	8.2	58
	1300	0.93	9.5	1.24	9.2	1.30	8.9	54
	1900	0.85	9.9	1.31	9.9	1.33	9.8	66
5	0100	0.76	9.5	1.17	9.2	1.27	9.8	56
	0700	0.59	9.9	1.09	9.9	1.13	9.8	62
	1300	0.57	9.9	1.04	9.9	1.11	9.8	60
	1900	0.44	10.3	0.87	10.7	0.85	9.8	68
6	0100	0.38	11.2	0.71	9.5	0.88	9.8	58
	0700	0.40	10.7	0.64	11.2	0.70	10.8	86
	1300	0.43	11.7	0.73	11.2	0.69	10.8	58
	1900	0.41	4.5	0.59	10.7	0.55	10.8	72
7	0100	0.25	4.9	0.43	11.2	0.43	10.8	94
	0700	0.26	5.2	0.36	10.7	0.34	10.8	94
	1300	0.40	4.2	0.59	4.2	0.56	4.2	10
	1900	0.55	5.9	0.73	5.7	0.74	5.9	40
8	0100	0.25	2.8	0.50	5.2	0.44	5.3	42
	0700	0.24	5.9	0.37	6.3	0.35	10.8	58
	1300	0.11	14.3	0.26	13.5	0.34	13.6	84
	1900	0.23	12.2	0.36	12.2	0.38	12.0	72
9	0100	0.14	5.8	0.28	11.2	0.30	10.8	74
	0700	1.56	6.6	2.07	6.8	2.01	6.6	52
	1300	0.80	7.2	1.41	7.4	1.41	7.1	54
	1900	1.02	7.8	1.25	7.8	1.14	8.2	56
10	0100	0.47	8.6	0.95	8.3	0.96	8.2	58
	0700	0.64	5.5	1.00	5.6	1.04	5.9	124
	1300	0.48	7.0	0.89	10.3	0.91	10.8	70
	1900	0.56	11.7	0.82	11.7	0.87	10.8	58

Table 4
Wave Data (continued)

Mar 1997											
Day	Hour	641		625		3111			630		
		Pressure Hmo,m	Gauge Tp,sec	Baylor Hmo,m	Gauge Tp,sec	8 Meter Hmo,m	Array Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec	
11	0100	0.39	11.2	0.75	10.7	0.81	10.8	66	inoperative		
	0700	0.52	12.2	0.88	11.2	0.89	12.0	92	0.96	11.8	
	1300	0.40	13.5	0.76	12.2	0.82	12.0	90	0.87	10.1	
	1900	0.47	15.1	0.73	12.2	0.79	12.0	68	0.89	12.6	
12	0100	0.44	15.1	0.68	12.9	0.58	12.0	68	0.74	11.8	
	0700	1.25	5.9	1.54	6.0	1.64	6.2	32	0.74	11.8	
	1300	0.91	6.3	1.09	6.8	1.05	6.6	36	1.32	5.9	
	1900	0.68	5.9	0.94	7.8	0.93	7.1	36	1.10	7.2	
13	0100	0.48	6.0	0.66	6.3	0.67	13.6	88	0.79	7.7	
	0700	0.32	12.2	0.59	12.2	0.62	12.0	68	0.70	6.7	
	1300	0.47	3.9	0.74	12.9	0.69	13.6	86	0.87	13.4	
	1900	0.62	4.9	1.01	7.8	1.00	4.1	52	1.22	7.7	
14	0100	0.77	5.5	1.19	4.9	1.05	5.0	60	1.41	5.1	
	0700	0.59	4.9	0.98	5.3	1.13	5.9	48	1.26	5.1	
	1300	1.03	7.8	1.27	7.8	1.44	8.9	90	1.99	8.4	
	1900	0.91	9.5	1.25	9.2	1.27	8.9	82	1.42	9.1	
15	0100	1.07	10.3	1.36	9.5	1.48	10.8	106	1.72	10.6	
	0700	0.90	11.2	1.28	11.7	1.37	10.8	106	1.54	11.2	
	1300	1.19	6.1	1.55	5.7	1.65	6.2	32	1.94	5.9	
	1900	0.87	6.6	1.33	6.5	1.24	9.8	106	1.68	6.7	
16	0100	0.64	9.9	0.81	9.2	0.84	9.8	106	1.10	10.1	
	0700	0.65	5.1	0.98	9.5	0.93	9.8	106	1.17	9.1	
	1300	0.71	6.5	0.92	6.5	0.95	5.9	48	1.21	9.1	
	1900	0.51	6.1	0.78	8.9	0.79	8.9	106	1.01	5.9	
17	0100	0.54	5.9	0.69	6.5	0.71	8.9	108	0.86	5.9	
	0700	0.34	17.1	0.65	6.5	0.61	6.2	52	0.71	6.3	
	1300	0.34	16.0	0.61	16.0	0.56	15.7	82	inoperative		
	1900	0.29	18.3	0.54	17.1	0.56	18.5	72			
18	0100	0.26	17.1	0.42	17.1	0.45	15.7	222			
	0700	0.20	16.0	0.35	16.0	0.36	15.7	80			
	1300	0.19	16.0	0.29	15.1	0.32	15.7	78			
	1900	0.25	15.1	0.41	14.3	0.34	15.7	60			
19	0100	0.54	5.1	1.02	5.2	1.16	5.6	86			
	0700	0.71	6.0	1.30	6.1	1.39	6.2	62			
	1300	0.98	7.0	1.83	7.2	1.83	7.1	58			
	1900	0.95	8.1	1.64	7.4	1.66	8.2	62			
20	0100	0.84	8.6	1.55	7.8	1.65	8.2	62	inoperative		
	0700	0.81	9.2	1.34	11.7	1.35	8.9	68			
	1300	0.53	10.7	1.06	7.8	1.09	10.8	66			
	1900	0.49	10.3	0.92	9.5	1.00	9.8	62			

Table 4
Wave Data (concluded)

Mar 1997									
Day	Hour	641		625		3111		630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Waverider Dir,TN	Hmo,m
21	0100	0.36	9.5	0.80	9.5	0.81	8.9	84	
	0700	0.30	9.2	0.59	9.5	0.64	9.8	62	
	1300	0.25	9.2	0.59	9.2	0.65	8.9	78	
	1900	0.29	9.2	0.54	9.5	0.56	9.8	66	
22	0100	0.22	9.5	0.44	9.2	0.49	8.9	76	
	0700	0.27	8.6	0.42	9.2	0.47	9.8	68	
	1300	0.18	5.6	0.35	8.6	0.35	8.9	82	
	1900	0.99	5.0	1.17	5.2	1.29	5.0	18	
23	0100	1.31	6.5	1.72	6.6	1.70	5.9	48	inoperative
	0700	1.21	6.9	1.29	6.4	1.55	6.6	0	
	1300	0.66	6.1	0.84	6.0	0.84	6.2	36	
	1900	0.57	6.5	0.71	6.6	0.67	7.1	58	
24	0100	0.39	5.6	0.69	7.0	0.64	6.6	58	
	0700	0.37	6.0	0.62	9.5	0.74	4.1	30	
	1300	0.77	5.3	1.02	5.1	0.93	5.0	46	
	1900	0.77	6.3	1.08	5.9	0.96	6.2	52	
25	0100	0.49	6.0	0.79	6.3	0.78	6.2	52	
	0700	0.62	4.3	1.05	7.8	0.99	4.6	94	
	1300	0.33	9.2	0.84	8.9	0.77	8.9	82	
	1900	0.35	8.6	0.63	8.6	0.70	8.2	66	
26	0100	0.39	7.0	0.74	6.8	0.81	7.1	106	
	0700	0.58	7.8	0.82	7.4	0.76	8.2	106	
	1300	0.32	7.0	0.55	8.6	0.57	8.2	106	inoperative
	1900	0.49	7.2	0.66	8.1	0.66	7.6	110	
27	0100	0.36	8.6	0.56	8.6	0.55	8.2	108	
	0700	0.40	8.1	0.59	8.3	0.62	7.6	108	0.75 8.3
	1300	0.36	8.1	0.58	7.8	0.61	8.2	86	0.78 8.4
	1900	0.34	7.8	0.56	7.6	0.57	7.6	108	0.73 7.7
28	0100	0.24	8.1	0.42	7.8	0.46	8.2	88	0.55 7.7
	0700	0.23	7.6	0.37	7.6	0.44	7.1	108	0.52 7.7
	1300	0.23	8.1	0.38	8.3	0.40	7.6	108	0.45 8.4
	1900	0.26	8.6	0.37	7.4	0.45	8.2	106	0.47 7.2
29	0100	0.40	6.1	0.58	6.5	0.57	7.1	108	0.83 6.7
	0700	0.35	6.6	0.55	7.8	0.58	6.6	110	0.69 7.7
	1300	0.39	6.6	0.55	8.9	0.57	7.6	108	0.78 7.7
	1900	0.35	7.0	0.54	7.6	0.59	7.6	108	0.73 7.2
30	0100	0.36	8.1	0.49	8.3	0.53	8.2	108	0.70 7.7
	0700	0.29	8.9	0.48	9.2	0.48	8.9	102	0.66 9.1
	1300	0.29	8.3	0.44	9.5	0.46	8.9	104	0.58 8.4
	1900	0.26	8.6	0.44	7.8	0.51	8.2	104	0.60 8.4
31	0100	0.31	7.8	0.49	7.6	0.52	8.2	106	0.65 8.4
	0700	0.29	3.9	0.53	7.6	0.68	4.1	0	0.87 4.2
	1300	1.03	5.7	1.03	5.6	1.17	6.2	30	1.54 5.9
	1900	0.94	6.0	1.04	5.9	1.12	6.2	28	1.28 6.3
Mean		0.53	8.3	0.81	8.5	0.83	8.7	75	0.99 8.1
Std dev		0.29	3.1	0.37	2.7	0.38	2.7	30	0.39 2.1

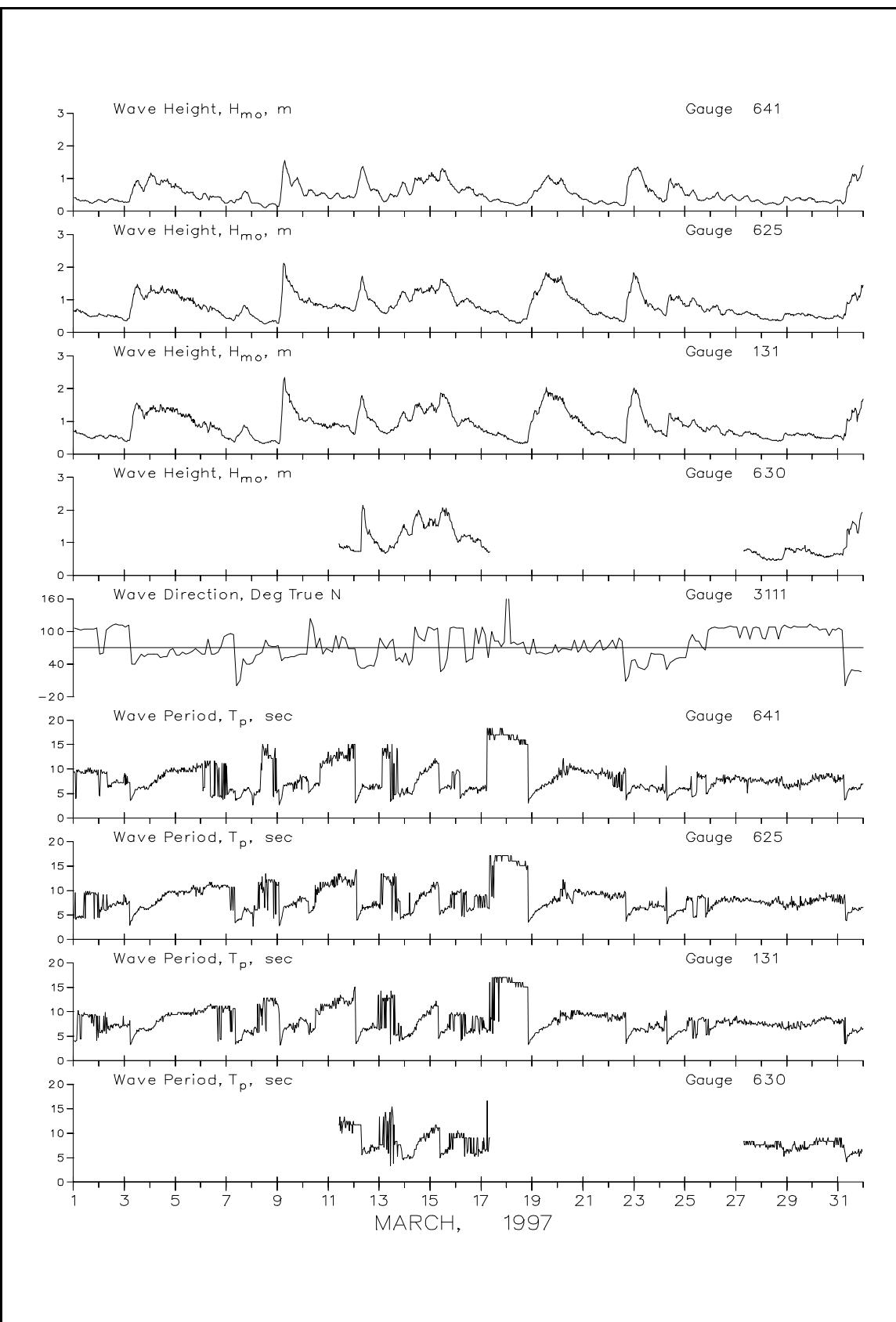


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

MARCH 1997																	
		Cross	Long		Cross	Long		Cross	Long								
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100					1300						22	100				
	700					1900							700				
	1300					12	100						1300				
	1900					700							1900				
2	100	inoperative				1300	inoperative					23	100	inoperative			
	700					1900							700				
	1300					1300							1300				
	1900					13	100						1900				
3	100					1300						24	100				
	700					1900							700				
	1300					14	100						1300				
	1900					700							1900				
4	100					1300						25	100				
	700					1900							700				
	1300					15	100						1300				
	1900					700							1900				
5	100	inoperative				1300	inoperative					26	100	inoperative			
	700					1900							700				
	1300					16	100						1300				
	1900					700							1900				
6	100					1300						27	100				
	700					1900							700				
	1300					17	100						1300				
	1900					700							1900				
7	100					1300						28	100				
	700					1900							700				
	1300					18	100						1300				
	1900					700							1900				
8	100	inoperative				1300	inoperative					29	100	inoperative			
	700					1900							700				
	1300					19	100						1300				
	1900					700							1900				
9	100					1300						30	100				
	700					1900							700				
	1300					20	100						1300				
	1900					700							1900				
10	100					1300						31	100				
	700					1900							700				
	1300	inoperative				21	100	inoperative					1300	inoperative			
	1900					700							700				
11	100					1300							1300				
	700					1900							1900				

KEY:

+cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Mar 1997												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	0	87	87	160	-35	-29	45	290	South	15	N	
2	6	-38	39	349	-14	-68	69	329	South	44	N	
3	-15	9	18	219	-12	16	21	197	South	38	S	
4	0	76	76	160	-42	76	87	189	North	47	S	
5	-3	34	34	166	-4	38	38	166	North	7	S	
6	21	17	27	109	27	36	45	123	no observation			
7	3	30	31	154	-14	47	49	177	North	33	S	
8	10	-22	24	4	0	-5	5	340	South	3	S	
9	-3	55	55	163	-30	102	106	177	North	58	S	
10	16	13	20	70	-1	-25	25	337	South	3	N	
11	3	-7	7	2	-22	-55	60	318	South	38	S	
12	-5	51	51	166	0	122	122	160	North	146	S	
13	-3	5	6	187	12	-20	23	11	South	21	S	
14	4	-41	41	346	-24	-61	66	318	South	38	N	
15	0	47	47	160	0	61	61	160	North	17	S	
16	-3	34	34	166	33	22	39	104	South	12	S	
17	-1	14	14	250	9	44	44	149	North	9	S	
18	8	-18	20	4	9	-17	19	7	South	0		
19	-12	10	16	250	-17	87	89	171	North	53	S	
20	0	61	61	160	-17	87	89	171	North	27	S	
21	5	-3	6	37	-7	-47	47	331	South	27	N	
22	18	-9	20	44	0	-38	38	340	South	13	N	
23	-17	68	70	174	-10	68	68	169	North	52	S	
24	-11	76	77	169	0	87	87	160	North	82	S	
25	-1	-13	13	334	-21	-61	65	321	South	37	N	
26	18	-23	29	19	-36	-51	62	305	South	40	N	
27	14	-21	25	13	-1	-15	15	334	South	10	N	
28	2	-47	47	343	-11	-44	45	326	South	35	N	
29	14	-36	39	2	-49	-47	68	294	South	43	N	
30	-3	-12	12	326	0	-27	27	340	South	9	N	
31	1	21	21	157	26	44	51	129	North	18	S	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Mar 1997

Day	Time	Wave Approach Angle at Pier End deg from True N		Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary		Temp.,C	Density g/cc	Secchi Vis.,m
1	0909	85		63	8.6	1.0177	1.2
2	0902	130		69	8.3	1.0250	0.9
3	0730	40		92	8.3	1.0257	2.1
4	0725	40		243	8.6	1.0196	0.6
5	0720	70		176	8.9	1.0191	0.9
6	0830	0	40	55	8.9	1.0240	1.5
7	0750	20		49	8.9	1.0242	0.6
8	1145	100		81	9.2	1.0240	0.9
9	1058	40	25	354	8.1	1.0249	0.6
10	0755	115		92	9.2	1.0216	1.8
11	0712	95		98	9.2	1.0209	2.1
12	0703	30		306	10.3	1.0205	0.3
13	0705	70		97	9.4	1.0207	1.8
14	0640	80	110	64	10.0	1.0206	1.8
15	0745	50		125	10.0	1.0220	0.3
16	0825	40		73	9.4	1.0230	3.0
17	0731	50		88	8.9	1.0208	2.4
18	0734	90		66	9.7	1.0234	2.7
19	0812	45	65	276	10.6	1.0225	1.2
20	0818	70		206	9.7	1.0171	0.3
21	0833	75		76	9.7	1.0205	0.9
22	0944	100		77	10.0	1.0237	1.5
23	0952	35		101	9.4	1.0235	2.1
24	0814	25		103	9.7	1.0217	2.4
25	0932	75		96	9.7	1.0207	2.4
26	0936	110		97	10.0	1.0242	1.8
28	0827	105		54	9.7	1.0251	2.1
27	0856	15	90	52	10.0	1.0235	3.0
29	0815	105		86	10.0	1.0249	2.1
30	1025	110	50	49	11.1	1.0248	0.9
31	0702	no observation		72	10.3	1.0246	1.5

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

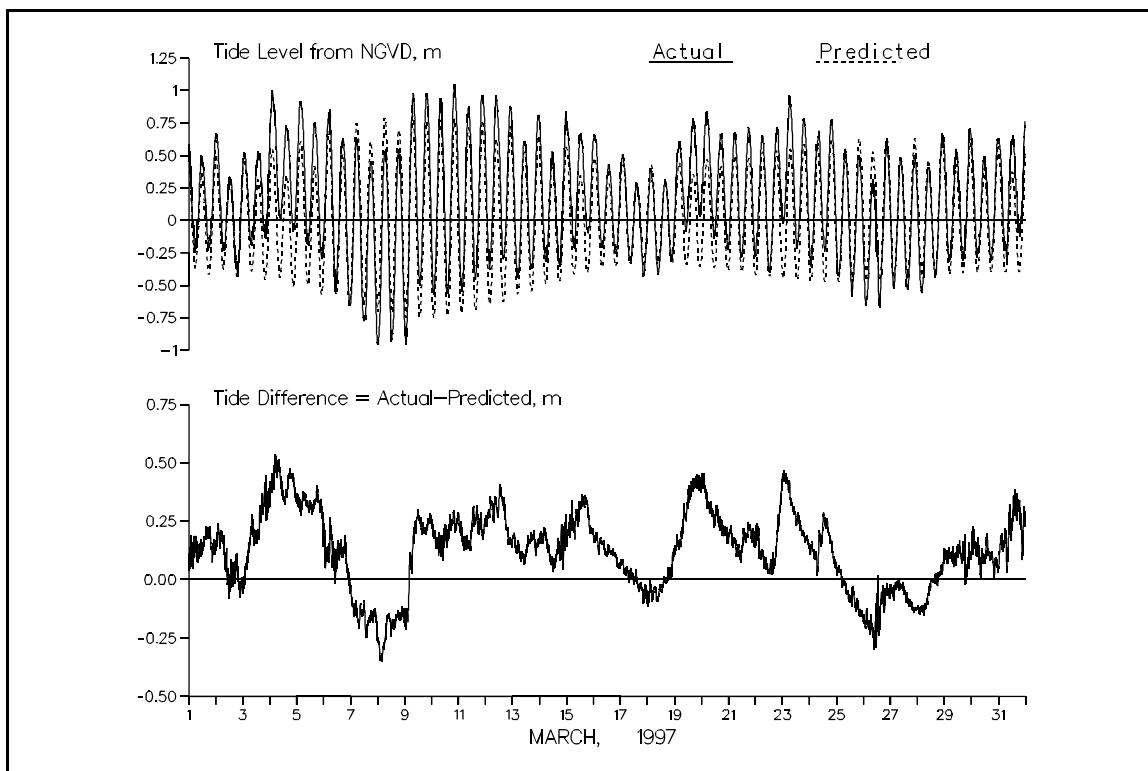


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

MAR 1997 Tide Levels																
Day	High			Low			Mean	Range	High			Low			Mean	Range
	Time	m	Day	Time	m	Day			Time	m	Day	Time	m	Day		
1	1124	0.50	1	0600	-0.25	1	0.13	0.75	17	0200	0.51	16	1948	-0.25	0.12	0.77
1	2354	0.67	1	1730	-0.23	1	0.21	0.90	17	1348	0.29	17	0900	-0.33	-0.01	0.63
2	1224	0.33	2	0724	-0.23	2	0.06	0.56	18	0248	0.40	17	2030	-0.43	-0.01	0.83
3	0106	0.52	2	1918	-0.43	3	0.06	0.95	18	1542	0.32	18	0924	-0.42	-0.04	0.73
3	1324	0.53	3	0800	-0.20	3	0.18	0.73	19	0418	0.61	18	2112	-0.32	0.17	0.93
4	0230	1.00	3	2036	-0.14	4	0.42	1.14	19	1618	0.78	19	1024	-0.09	0.36	0.87
4	1500	0.73	4	0948	0.00	4	0.38	0.73	20	0518	0.84	19	2300	0.03	0.43	0.81
5	0406	0.92	4	2100	-0.09	5	0.42	1.01	20	1642	0.67	20	1100	-0.14	0.27	0.80
5	1612	0.75	5	1024	-0.20	5	0.29	0.95	21	0554	0.68	20	2342	-0.23	0.22	0.91
6	0542	0.86	5	2224	-0.30	6	0.25	1.16	21	1748	0.72	21	1130	-0.28	0.21	1.00
6	1700	0.63	6	1012	-0.55	6	0.08	1.19	22	0606	0.65	22	0006	-0.28	0.19	0.94
7	0500	0.64	6	2248	-0.66	7	-0.04	1.30	22	1912	0.72	22	1248	-0.41	0.16	1.13
7	1748	0.46	7	1130	-0.78	7	-0.18	1.24	23	0624	0.96	23	0036	-0.03	0.43	0.99
8	0648	0.54	8	0000	-0.96	8	-0.20	1.50	23	1918	0.78	23	1242	-0.22	0.28	1.00
8	1836	0.55	8	1218	-0.94	8	-0.17	1.48	24	0818	0.69	24	0106	-0.35	0.18	1.04
9	0736	0.98	9	0106	-0.96	9	0.04	1.94	24	1948	0.78	24	1348	-0.24	0.25	1.02
9	1942	0.98	9	1330	-0.50	9	0.26	1.48	25	0754	0.54	25	0154	-0.43	0.04	0.97
10	0754	0.94	10	0200	-0.57	10	0.19	1.51	25	2012	0.50	25	1354	-0.59	-0.03	1.09
10	2012	1.05	10	1406	-0.57	10	0.26	1.62	26	0806	0.31	26	0200	-0.65	-0.16	0.97
11	0842	0.88	11	0248	-0.55	11	0.18	1.43	26	2054	0.62	26	1442	-0.67	0.00	1.30
11	2130	0.96	11	1454	-0.46	11	0.29	1.42	27	0900	0.48	27	0242	-0.53	-0.01	1.01
12	0936	0.96	12	0342	-0.38	12	0.30	1.34	27	2112	0.50	27	1512	-0.53	-0.02	1.04
12	2206	0.88	12	1536	-0.30	12	0.29	1.19	28	1006	0.41	28	0348	-0.56	-0.07	0.97
13	1006	0.61	13	0406	-0.44	13	0.10	1.06	28	2148	0.67	28	1542	-0.44	0.12	1.11
13	2324	0.82	13	1706	-0.37	13	0.22	1.18	29	1030	0.55	29	0442	-0.32	0.11	0.87
14	1112	0.53	14	0548	-0.32	14	0.10	0.85	29	2312	0.71	29	1612	-0.31	0.19	1.02
14	2330	0.84	14	1824	-0.35	14	0.21	1.19	30	1142	0.50	30	0454	-0.28	0.11	0.78
15	1230	0.67	15	0724	-0.22	15	0.25	0.89	31	0048	0.63	30	1730	-0.31	0.18	0.95
16	0030	0.67	15	1848	-0.10	16	0.28	0.77	31	1236	0.66	31	0724	-0.31	0.21	0.96
16	1330	0.44	16	0736	-0.21	16	0.11	0.65								

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in December 1996 and the survey(s) in March 1997 on profile line 188, located 517 m south of the pier.

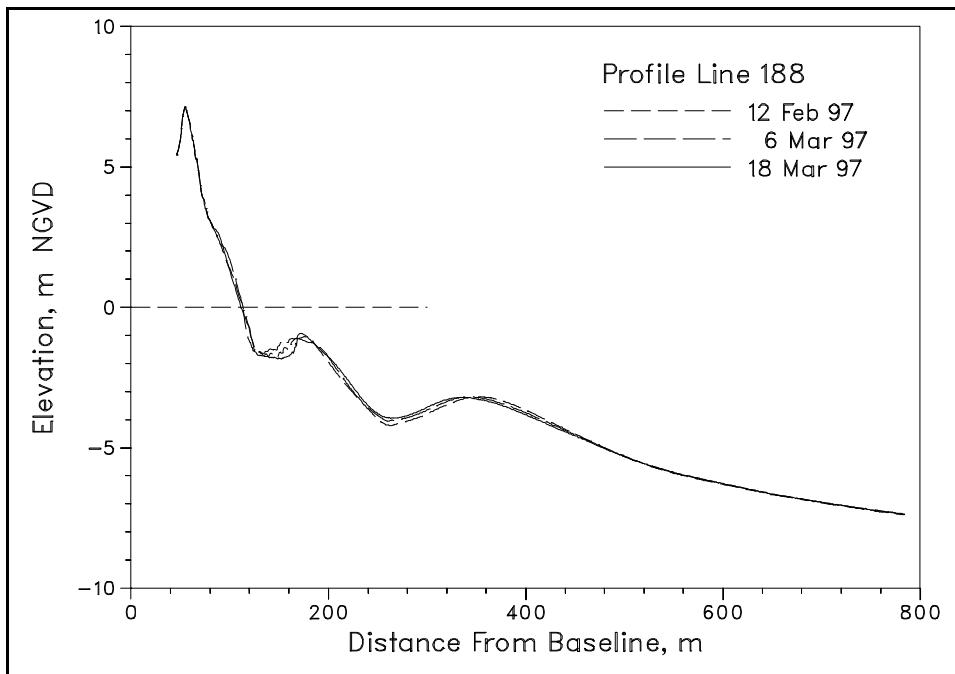


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1997. Cross-hatched areas indicate changes to the annual envelope which occurred in March.

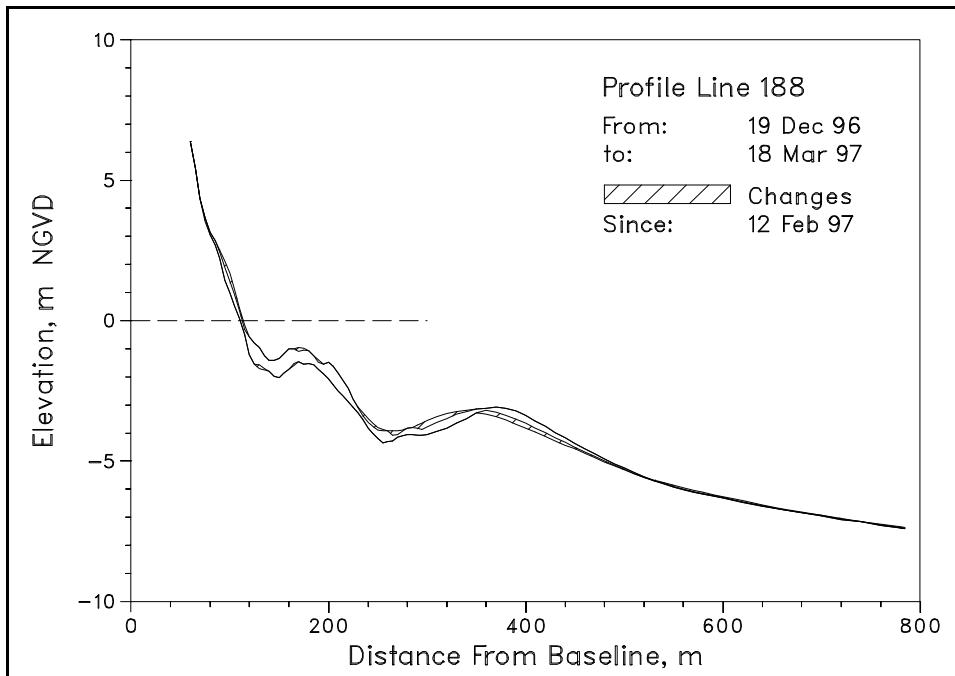
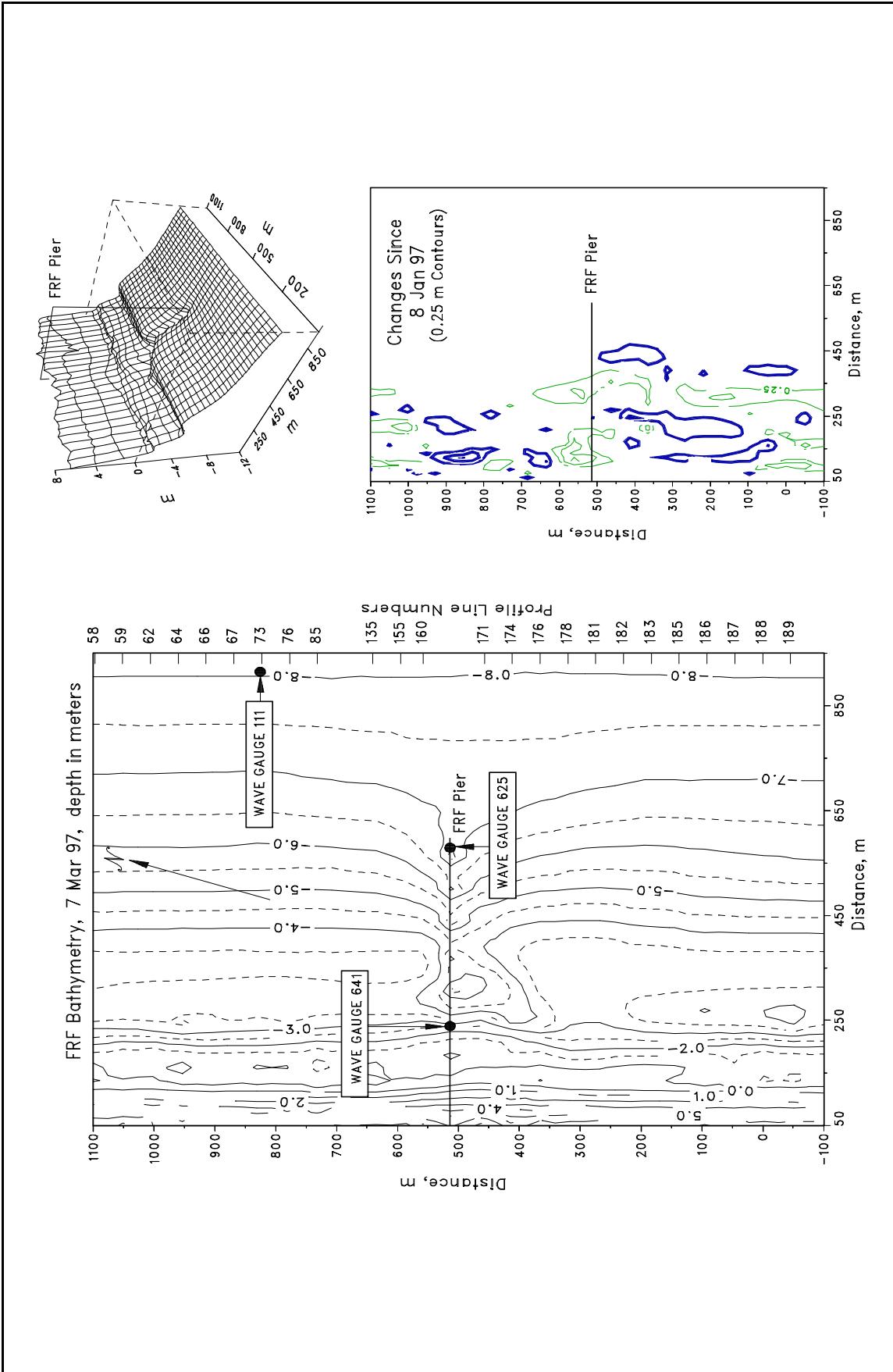


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 7 March. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
** Dec (0000)	** Dec (0000)

B. Storm Synopsis.

Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system over Cape Hatteras. Winds intensified as the low pressure system moved along the North Carolina coast and began moving out to sea by the morning of ** March. Maximum onshore winds (NE) reached ** m/s at 0000 EST on ** March. The minimum atmospheric pressure was *** mb. The maximum H_{mo} , at gauge 630, reached *.* m ($T_p=**.*$ s) at 0000 EST on ** March. There was * mm of precipitation.